

Vagal Stimulation with Laryngeal Electromyography to Guide Recurrent Laryngeal Nerve Reinnervation in Children

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SUMMARY

Introduction: Ansa-recurrent laryngeal nerve (RLN) reinnervation procedures are now often first line treatments for some children with unilateral vocal fold immobility (UVFI). While many describe that children with prolonged denervation and true vocal fold (TVF) atrophy should not undergo this procedure, there has been no gold standard means of identifying true denervation.

Importance: Here, we describe a novel technique using evoked vagal electromyography (VEMG) to predict degree of chronic nerve injury prior to RLN reinnervation in children, which has evolved from intraoperative neural monitoring during neural monitored thyroid surgery.

Results: Our cases demonstrate that both the mean amplitude and latency of evoked signals from VEMG can be used to interpret the state of injury of the nerve and guide intraoperative decision-making. Pre-operative and 6-month post-operative PVRQOL survey data were recorded from caregivers. When age-appropriate, maximum phonation time and s/z ratios were recorded. Results were consistent with predictions made by VEMG intraoperatively, where amplitudes and latencies were compared to normalized values¹.

Conclusion: Evoked vagal stimulation is a simple, readily available technique that may play an important role in predicting likelihood of success with pediatric ansa-RLN reinnervation. Larger clinical studies are needed to correlate such testing with long term vocal and aspiration outcomes.

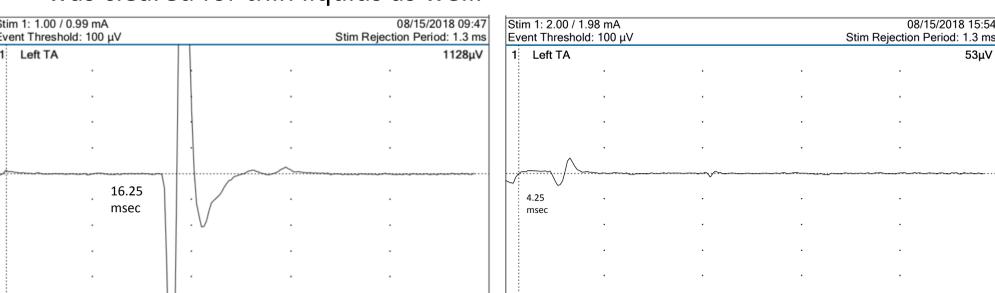
METHODS

This is a report of three pediatric patients who successfully underwent ANSA-RLN using VEMG to guide intraoperative decision-making. **EMG hookwire electrodes** (Medtronic, Jacksonville, FL) are inserted into the bilateral thyroarytenoid (TA) and posterior cricoarytenoid (PCA) muscles under direct laryngoscopy (DL). Upon **identification of the vagus nerve in the carotid sheath at the level of the cricoid**, 1 cm of nerve was exposed and intermittently stimulated using a **standard Prass probe** (Medtronic, Jacksonville, FL) at 1.0 mA and responses were recorded (Figures 1-3). Amplitudes and latencies were compared to those reported by Schneider et al.¹¹ IML was performed with Prolarynx gel (Merz, Raleigh NC). Vocal outcomes were assessed using the pediatric voice-related quality of life questionnaire (PVRQoL), s/z ratio, and maximum phonation time (MPT) when age-appropriate. A score of 100 on the PVRQoL demonstrates the best possible perceived quality of life in terms of voice quality and use. Details for cases can be found in Tables 1 and 2.

CASES

Case #1:

- 2-year old female with a history of prematurity and PDA ligation.
- Presented with hoarseness, aspiration with thin liquids, and left UVFI.
- Underwent left injection medialization laryngoplasty with improvement in her hoarseness but not swallowing.
- Her parents elected to proceed with neck exploration, VEMG, and possible ANSA-RLN depending upon VEMG findings.
- Amplitude and latency of the VEMG of the ipsilateral TA were 1128 μ V & 16 ms, respectively. The normal amplitude but significantly prolonged latency was interpreted to mean that while the neural circuit was intact, it was damaged during the PDA ligation & thus showed a slowed response.
- After 6 months, her voice had improved. The pre-operative PVRQOL administered to her parents was 51.5, and this had improved to 78.5. She was cleared for thin liquids as well.



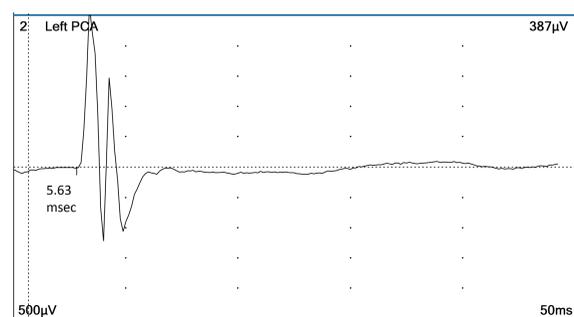
Figures 1 & 2: Evoked Vagal Electromyography Cases #1 & #2

Case #2:

- 14-year old female with history of prematurity and PDA ligation.
- Hoarseness, choking on thin liquids, and left UVFI.
- Laryngeal EMG with visible action potentials of the right cord and electrical silence on the left.
- IML was performed without improvement in her hoarseness nor swallowing, but her parents also elected to proceed with possible ANSA-RLN depending on VEMG.
- Amplitude and latency of the VEMG of the ipsilateral TA were 53 μ V and 4.25 ms, respectively (Figure 2). Intraoperative discussion was had with the family. Given vagal stimulation revealed some, albeit low, amplitude (Table 2), we proceeded with ANSA-RLN with IML rather than aborting to thyroplasty as some neuronal activity existed.
- After 6 months, the breathiness of her voice had improved some, but she still reported inability to achieve the loudness she desired. Her PVRQOL actually worsened, falling nearly 12 points. Her s/z ratio at this time was 1.7 (normal 1.0) and her MPT was 8.7 s (normal for age >9.0 s)¹. She continued to have her baseline level of dysphagia.

Case #3:

- 3-year old boy born at 38 weeks gestation underwent tracheoesophageal fistula repair at birth and developed left UVFI as well as esophageal atresia.
- Aspiration and left UVFI.
- His parents elected to proceed with possible ANSA-RLN depending on VEMG.
- Hookwire at the ipsilateral TA dislodged and the VEMG of the PCA was used as a substitute.
- Amplitude and latency of the VEMG of the ipsilateral PCA were 387 μ V and 5.63 ms, respectively (Figure 3). Given these values fell within the normal range (Table 2), we interpreted this information to mean the neural circuit was intact. We proceeded with ANSA-RLN with IML.
- After 6 months, he was swallowing all consistencies. His PVRQOL was 100 pre-operatively and 90.5 post-operatively. His s/z ratio at this time was 1.49 (normal 1.0) and his MPT was 6.13s (normal for age >6.0 s)¹.



Figures 3: Evoked Vagal Electromyography Case #3

DISCUSSION

Here, we present, to our knowledge, the first three cases to use intraoperative VEMG to interpret the status of the RLN circuit prior to ANSA-RLN. This nuanced technique provides surgeons with necessary information in order to guide intraoperative decision-making. Two of our cases demonstrated improvement in aspiration status as predicted, with one of these patients who presented with hoarseness also demonstrating vocal improvement. Case #2 demonstrates this technique may provide information to predict when an ANSA-RLN procedure may not be successful, thus guiding the surgeon towards thyroplasty. This technique may therefore provide additional information to optimize post-operative outcomes in patients with UVFI. Larger clinical studies are needed to correlate such testing with long term vocal and aspiration outcomes and also to develop a construct in which to better interpret VEMG data to predict success of reinnervation.